The asterostomatid echinoid *Antillaster* from the Paradash Group (Middle Eocene) of the Nakhichevan Region of Azerbaijan

Kenneth J. McNamara[1] and Oktay H. Melikov[2]

[1] Department of Earth and Planetary Sciences, Western Australian Museum, Francis Street, Perth, Western Australia 6000, Australia

[2] Azerbaijan State Oil Academy, 370102 Azadlik pr. 20, Baku, Azerbaijan

Abstract – The asterostomatid echinoid *Antillaster* has previously been recorded only from the Caribbean region and northeastern South America. Here we report the first occurrence of this genus from outside the Americas, in the Lesser Caucasus, where it has been found in Middle Eocene sediments of the Paradash Group in the Nakhichevan region of Azerbaijan. The material is described as *Antillaster bagmanovi* sp. nov. It is the earliest known occurrence of the genus. Its presence in the Paratethys, in a region far removed from previous known occurrences, has significant palaeobiogeographic implications. Its disappearance from the Lesser Caucasus, but persistence in the Caribbean, may be linked to the contraction of the Tethys during the Cenozoic.

INTRODUCTION

Eocene sediments in the Nakhichevan region of Azerbaijan have long attracted the attention of many investigators, due to their good exposure and extensive foraminiferal and molluscan fauna. The dating of the predominantly clay-sand facies as being Eocene is based on this rich foraminiferal and molluscan fauna (Azizbekov 1961; Bagmanov 1966, 1980; Paffengoltc 1979). The presence of an Eocene echinoid fauna in the Nakhichevan region remained unknown until 1958 when, in addition to the foraminifers and molluscs from sections in Juga, Daralik, Ilandag and Bilav, M.A. Bagmanov collected a rich fauna of echinoids from the Paradash Group. Unfortunately, this fauna remained unstudied for many years. However, in 1984 Bagmanov kindly passed his echinoid collection over to one of us (O.H.M). During 1985–87 Melikov, to supplement this collection, collected additional material from Bagmanov's sections. These collections from the Paradash Group have yielded a rich echinoid fauna, comprising 25 species (Melikov in prep.). Current work by Melikov suggests that these species can be assigned to 14 genera in 11 families, and 5 orders. It is interesting that this species richness is in strong contrast to a fauna of equivalent age occurring in sediments in the neighbouring territory of Armenia, a mere 40–50 km away. Here only six species are known.

One of the more surprising echinoid finds from these sediments were large specimens of *Antillaster*. The asterostomatid echinoid *Antillaster* has previously been described only from the Caribbean region and northern South America, specifically from Eocene to Miocene sediments in Venezuela, Cuba, Jamaica, Bonaire, Antigua, Puerto Rico and Mexico (Kier 1984). Here we report the first record of this genus from outside the Caribbean region, in Middle Eocene sediments of the Lesser Caucasus region in Azerbaijan. This provides the earliest record of asterostomatid echinoids in the Paratethys region.

GEOLOGICAL SETTING AND BIOSTRATIGRAPHY

Middle Eocene sediments are are widespread in the southwestern part of the Nakhichevan region of Azerbaijan, extending to the Arax River, which marks the border with Iran. These sediments are separated by a pronounced unconformity from underlying Triassic sediments. This boundary is marked by a thick basal conglomerate. The Middle Eocene sediments are divided into three groups, which extend through six foraminiferal zones (Figure 1).

Daralik Group

Lower subgroup

Along the south-west limb of the Nakhichevan synclinal basin, particularly at Daralik (on the right bank of the Alinjachai River), this basal unit of the Middle Eocene sequence encompasses the *Nummulites laevigatus* zone and is represented mainly by conglomerates containing a series of isolated packets and lenses of limestones, clay-shale and sandstones. It is characterised by its reddish-

Upper Eocene		*Globerigina corpulenta* zone	Paradash Group	*Antillaster bagmanovi* sp. nov.
Middle Eocene	Bartonian	*Truncorotaloides rohri* zone		
		Acarinina rotundomarginata zone		
	Lutetian	*Globeriginatheka subconglobata* zone		
		Nummulites atacicus zone	Bilav Group	
		Morozovella aragonensis zone	Daralik Group	
		Nummulites laevigatus zone		

Figure 1   Biostratigraphic chart showing the foraminiferal zonation, stratigraphic groups and range of *Antillaster bagmanovi* in the Nakhichevan region of Azerbaijan Republic.

brown colouring. The thickness of the subgroup varies between 5–10 m to 120–150 m. This subgroup contains abundant *Nummulites* of Middle Eocene age, notably *N. laevigatus* (Brug.), *N. laevigatus* var. *lantaensis* Lerisch (B) and the echinoids *Porosoma lamberti* Checcia-Rispoli, *Triplacidia veronensis* Bittner, *Echinolampas daralagesensis* Poretzkaja, *E. blaviensis* Cotteau, *Echinanthus* cf. *issyaviensis* (Klein) and *Cyclaster subquadratus* (Desor). The presence of *N. laevigatus* indicates a Lower Lutetian age, foraminiferal zone P10.

Upper subgroup

This encompasses the *Morozovella aragonensis* zone. Up the section this predominantly conglomerate subgroup is intermixed with layers of shelly-sandstone, argillites and rarely limestones, containing abundant *Nummulites*. Within this subgroup in the Julfa region, occur lenses of gypsumised shale and aleurolites, 150 m thick. These sharply decrease in thickness along both limbs of the Bilav fold. The most common foraminifers in the zone are *Nummulites laevigatus* (Brug.) and *N. uranensis* Heim. Other foraminifers include *Acarinina bulbrooki* Bolli and *Globigerina*

postiloculinoides Chalilov. *Acarinina bulbrooki* occurs in the Lower Lutetian, P9 and P10. *N. uranensis* occurs in P10. Echinoids occurring in this upper subgroup are *Schizaster* (*Schizaster*) *rindensis* Poretzkaia, *S.(S.)* sp. nov., *Maretia hoffmani* Goldfuss and *M.* sp. nov.

Bilav Group

This is represented by tuffaceous conglomerate, tuff, tuffite of andesite to andesite-dacite composition and lenses of sandy shale. The total thickness of this group is 875 m. Bagmanov (1966) identified *Nummulites laevigatus* (Brug) within this group. Highly developed olistolites of very different-sizes is a characteristic feature of this group.

Paradash Group

Palaeontologically this group is divided into four biostratigraphical zones from the lowest *Globigerinatheka subconglobata* zone up through the *Acarinina rotundomarginata* zone, the *Truncorotaloides rohri* zone to the *Globigerina corpulenta* zone. The lower three are included within the Middle Eocene, the *Globigerina corpulenta* zone being Upper Eocene.

Globigerinatheka subconglobata *zone*

This overlies the tuffaceous conglomerate of the Bilava Group and is represented in its lower part by repeated beds of argillites, sandstones and clay/shales, having a total thickness of 126 m. These rocks are overlain by 70 m of repeated beds of dark red clay/shale, argillites and subordinate interbedded sandstones. Over these lie a 100 m thick sequence of greyish clay. This lowest subgroup is capped by a sequence of repeated sandstone and clay/shale 55 m thick, with a 4 m thick conglomerate at its base. The beds of this subgroup extend along the southern limb of Ilandag Mountain.

Clay/shale of all packets contain a foraminiferal assemblage containing *Acarinina bulbrooki* (Bolli), which ranges from P9–P10, *A. punctocarinata* Fleish, *Morozovella spinulosa* Cushman, which ranges from P10–P14, *Globigerina boweri* Bolli and *Nummulites laevigatus* Brug., which occurs in P10, and an echinoid fauna of *Schizaster (Schizaster) rindensis* Poretzkaia, *Linthia (Linthia) soudanensis* Bather, *Gualtieria (Gualtieria) damesi* Koch, *Eupatagus (Eupatagus) formosus* Loriol and *Maretia hoffmani* Goldfuss. *G. subconglobata* occurs in P11. Thus this sequence is probably near the Lower-Middle Lutetian boundary.

Acarinina rotundomarginata *zone*

This is represented by repeated beds of clay, sandstone and argillites having a total thickness of 391 m. Foraminifers present include *Subbotina frontosa* Subbotina (P11–P14), *Acarinina vievensis* Morozova, *Morozovella lehneri* Cushman (P12–P13), *Hantkenina alabamensis* Cushman (P12), *Nummulites acutus* (Sowerby) and *N. striatus* (Brug.). The species of echinoids recovered from this zone are: *Antillaster* sp. nov., *Gualtieria (Gualtieria) damesi* Koch, *Triplacidia veronensis* Bittner, *Schizaster (Schizaster)* sp. nov., *Schizaster (Paraster) rimosus* L. Agassiz, *Conoclypus conoideus* Leske, and *C. leymeriei* Cotteau. The planktic forams indicate a foraminiferal zone of P12, which is Upper Lutetian to early Lower Bartonian.

Truncorotaloides rohri *zone*

This consists of red-brownish (43 m) and greyish (25 m) clay with interbeds of sandstones containing nummulites. This zone is characterised by the presence of numerous *Truncorotaloides rohri* Brönnimann and Bermudez (P11–P14), *Globigerina incretacea* Chalilov, *G. praebulloides* Blay., *Nummulites brongniarti* D'Archiac and Haime (P12–P14), *N. perforatus* (Mont.)(P12–P14), *N. striatus* (Breys.). Echinoids occurring in this zone are *Conoclypus conoideus* Leske and *Antillaster* sp. nov. The foraminifers indicate a possible Upper Bartonian age.

Globigerina corpulenta *zone*

Sediments within this zone consist of repeated beds of nummulitic sandstones, clays and conglomerates, 50 m thick. Foraminifers present include *Nummulites striatus* (Brug.), *N. brongniarti* D'Archiac and Haime, *N. paradashensis* Mamedov, *N. fabiani* Prever, *N. rectus* Currey. *N. brongniarti* is Bartonian, and *N. fabiani* uppermost Bartonian to Lower Priabonian.

The Paradash Group would therefore seem to range from near the Lower-Middle Lutian boundary to the Upper Bartonian or earliest Pribonian. The sequence at Daralik probably occupies the entire Middle Eocene, possibly extending into the lowest part of the Upper Eocene.

SYSTEMATIC PALAEONTOLOGY

Order Spatangoida Claus, 1876

Family Asterostomatidae Pictet, 1857

Genus *Antillaster* Lambert, 1909

Type species

Asterostoma cubensis Cotteau, 1871; by original designation of Lambert, 1909, p. 103.

Diagnosis

Test large, low to high; apical system ethmolytic with 3 or 4 genital pores; petals long, wide, open, flush with test, or very slightly depressed; anterior ambulacrum with small pores, in slight groove or flush with test; some plates occluded at ends of petals; peristome large; periproct large, inframarginal; tubercles small, no fascioles; plastron mesamphisternous with large labrum, narrow sternal plates, large episternal plates; in some species first plate in interambulacrum 1 followed by single plate (after Kier 1984:131).

Remarks

Species of *Antillaster* are particularly characterised by their very large test size, typically reaching in excess of 100 mm test length, but sometimes to over 150 mm. *Antillaster* lacks any evidence of fascioles, hence its assignment to the Asterostomatidae. *Antillaster* bears a superficial resemblance to the brissid *Pharaonaster*, which is known from the Eocene of North Africa (Roman and Strougo 1994). However, *Antillaster* can be distinguished by its much larger test size and absence of fascioles; peripetalous and subanal fascioles are present in *Pharaonaster*. Another superficially similar form is *Hypsopatagus*, which is known from the Eocene to Oligocene of parts of Europe, Asia and North America. However, unlike *Antillaster* it has a peripetalous fasciole; is smaller; and has closed, rather than open, petals. On account of its large size,

absence of fascioles, distally open petals that are almost flush with the surface of the test, the form described herein from Azerbaijan is considered to be a species of *Antillaster*.

Antillaster bagmanovi sp. nov.
Figures 2–7

Diagnosis

Species of *Antillaster* with very slightly sunken petals; anteriorly divergent petals with very narrow interporiferous zone; peristome sunken; ambulacrum III deeply sunken orally.

Material

Holotype WAM 99.428, from Daralik, Nakhichevan region of Azerbaijan Republic; paratypes WAM 99.429 and 99.432 from the same horizon and locality; other specimens WAM 99.427, 99.430, 99.431 and 99.433 from the same horizon and locality. All specimens collected by O. H. Melikov from the *Acarinina rotundamarginata* zone,

Paradash Group (Middle Eocene – Upper Lutetian to early Lower Bartonian).

Etymology

Named in honour of palaeontologist M. A. Bagmanov.

Description

Test very large, reaching up to 154 mm TL; cupola-shaped, with apex anterior of centre; height about 50%TL; test longer than wide, ranging between 90–94%TL. Aboral surface declines more steeply anteriorly; ambitus broadly rounded. Shallow anterior notch present. Apical system anteriorly eccentric, 41–46%TL from anterior ambitus; ethmolytic, with four genital pores, madreporite extending posteriorly the same distance again as the distance between the anterior and posterior pairs of genital pores.

Ambulacrum III very slightly depressed aborally; pore pairs very small. Anterior petals slightly flexuous, curving anteriorly distally; very slightly
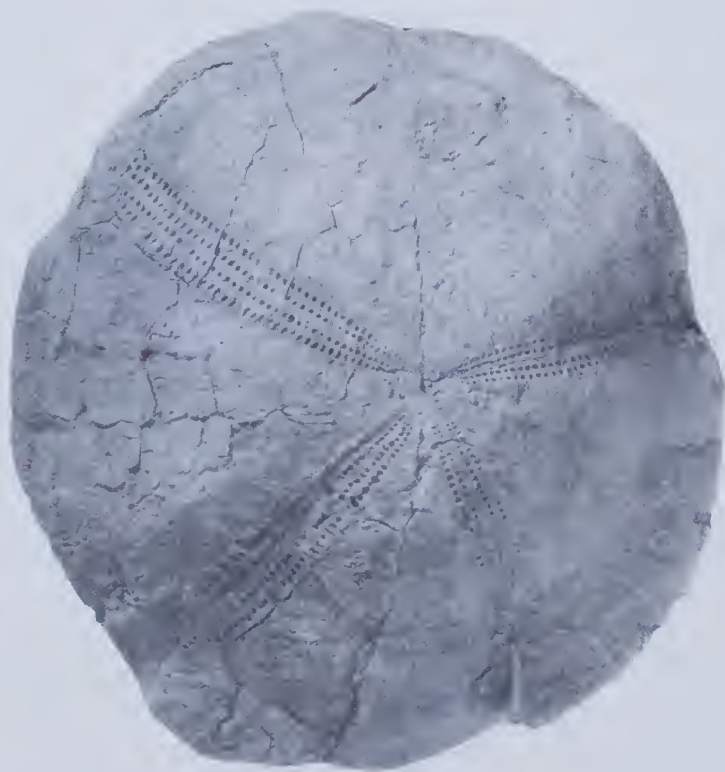

Figure 2   *Antillaster bagmanovi* sp. nov. WAM 99.428; holotype, aboral view; from Paradash Group (Middle Eocene), Daralik, Nakhichevan region of Azerbaijan Republic; x1.
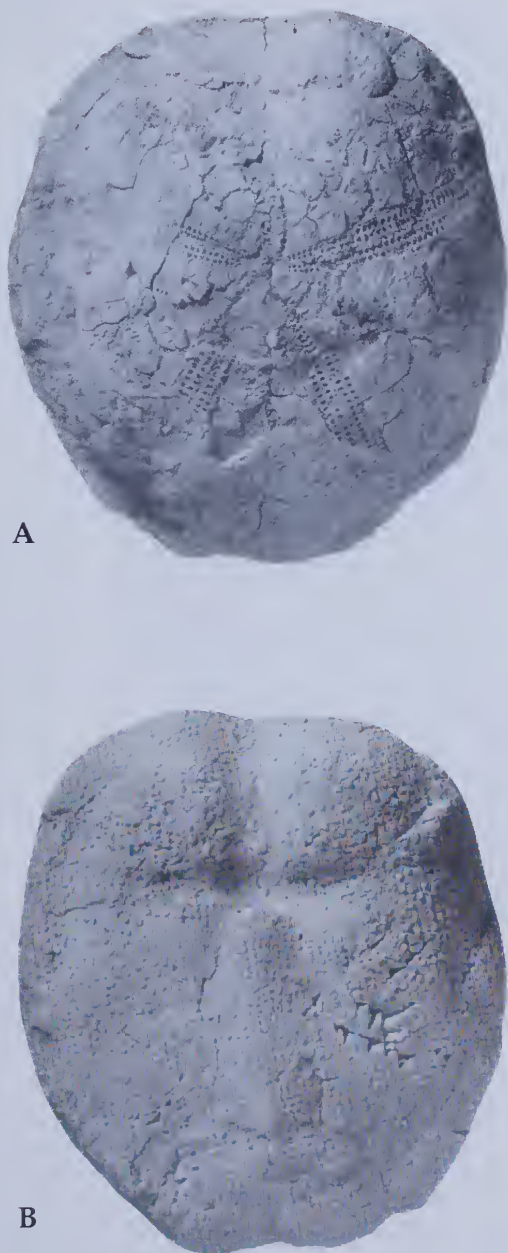
A

B

Figure 3   *Antillaster bagmanovi* sp. nov. WAM 99.429;
            paratype, A, aboral view, B, adoral view;
            from Paradash Group (Middle Eocene),
            Daralik, Nakhichevan region of Azerbaijan
            Republic; x1.

sunken; width 8–9%TL; diverging anteriorly at
about 140°; long, 43–48%TL, extending to the
ambitus; distally open; with up to 46 pore pairs in
each row; inner pores circular, outer pores slightly

elongate, not conjugate; interporiferous zone
narrow, being less than width of pore pairs in
smallest specimen (TL 89.5 mm) to slightly greater
in largest specimen. Posterior petals also very
slightly sunken; straight; slightly longer than
anterior, being 46–52%TL; with up to 51 pore pairs
in each row; nature of pore pairs and width of
interporiferous zone same as in anterior petals;
slightly wider than anterior petals, being 8–10%TL.
Terminal ambulacrum plates of petals sometimes
occluded.

Aboral tubercles relatively sparsely distributed;
range in diameter from 0.8 to 1.6 mm in largest
specimen. Set in a dense field of miliary tubercles.
Fascioles absent.

Oral surface with moderately convex
interambulacral areas and sunken ambulacra. These
are very weakly sunken ambitally, increasing in
depth to relatively deeply sunken peristome.
Ambulacrum III deeply sunken throughout.
Peristome width 11%TL; moderately crescentic;
posterior of peristome situated 30–35%TL from
anterior ambitus. Labrum strongly arcuate
anteriorly. Plastron length 24–34%TL, being
relatively longer in smaller specimens; width 17–
21%TL; gently convex. Episternal plates about half
the length of sternal plates, but episternal and
preanal plates combined are longer than sternal
plates. Periproct inframarginal, transversely oval,
width 12–13%TL. Adoral tuberculation slightly
more dense than on aboral surface; primary
tubercles of more even diameter; up to 1.5 mm;
slightly smaller on plastron than on lateral
interambulacra; set in field of dense miliary
tubercles.

Ontogenetic variation

While the partially weathered and usually
somewhat crushed nature of the specimens
precludes any detailed ontogenetic assessment of
the species, some differences are apparent between
the smallest specimen (WAM 99.429, test length 89
mm), compared with the other, larger, individuals
(125 to 154 mm). The plastron in the smaller
individual is distinctly narrower, with a length to
width ratio of 1:1.77, compared with 1:1.27 – 1:1.40
(n=5) in the larger ones. Furthermore, the petals are
slighty more sunken in larger individuals, as is the
anterior ambulacrum on the oral surface. The
interporiferous zone increases slightly in relative
width during ontogeny, being slightly narrower
than the width of the pore pairs in the smallest
specimen, becoming wider than pore pair width in
the largest specimens.

Remarks

Kier (1984) considered that there were two species
groups of *Antillaster* present in the Caribbean
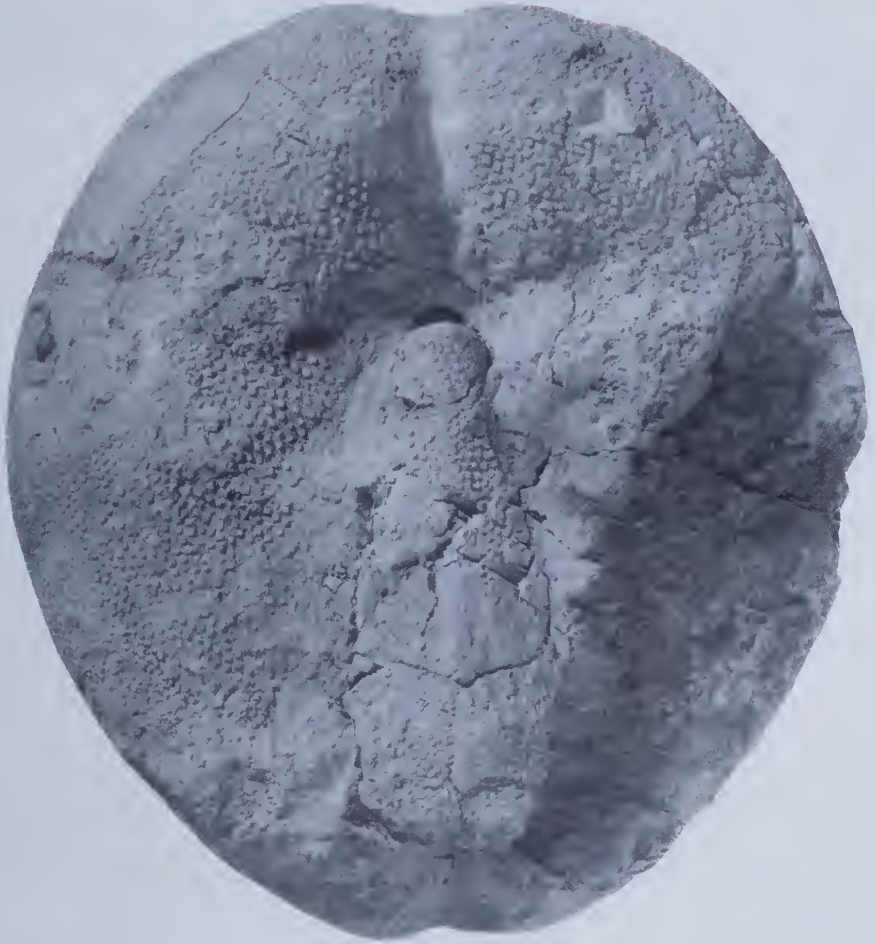region. One he characterised by its possession of a

Figure 4   *Antillaster bagmanovi* sp. nov. WAM 99.432; paratype, adoral view; from Paradash Group (Middle Eocene), Daralik, Nakhichevan region of Azerbaijan Republic; x1.

large, very high, steep-sided test, with a flat ventral surface and very wide petals. Species within this group range in age from the Oligocene to Miocene. Kier characterised the second group (which comprises species ranging in age from Eocene to Miocene) by the possession of relatively lower, more elongate test, more rounded ventral surface and narrower petals. In its possession of narrow petals and relatively lower test with more rounded ventral surface, *A. bagmanovi* resembles the second, probably more primitive, group.

Antillaster bagmanovi can be readily distinguished from all other described species of *Antillaster* by virtue of its slightly sunken petals that have a very narrow interporiferous zone, and orally possessing a relatively deeply sunken ambulacrum III. The only other known Eocene species of *Antillaster* are *A. arnoldi* Clark *in* Arnold and Clark, 1927 from the

Eocene of Jamaica and *A. albeari* Kier, 1984 from the Middle to Late Eocene of Cuba. The apical system is less anteriorly situated in *A. bagmanovi* than in these two species. Moreover, it has sunken petals that are more anteriorly divergent and narrower interporiferous zone. Although sharing slightly sunken petals, *A. bagmanovi* can be distinguished from *A. albeari* by possessing more anteriorly divergent petals, very much narrower anterior and posterior petals and interporiferous zone, more vaulted test and deeper anterior ambulacrum on the oral surface.

Like *A. elegans* Jackson, 1922 from the Miocene of Puerto Rico, *A. bagmanovi* has an apical system in a similar relative position, a little anterior of central, and slightly anteriorly divergent petals. However, the Azerbaijan species has slightly sunken petals, narrower interporiferous zone, deeper anterior
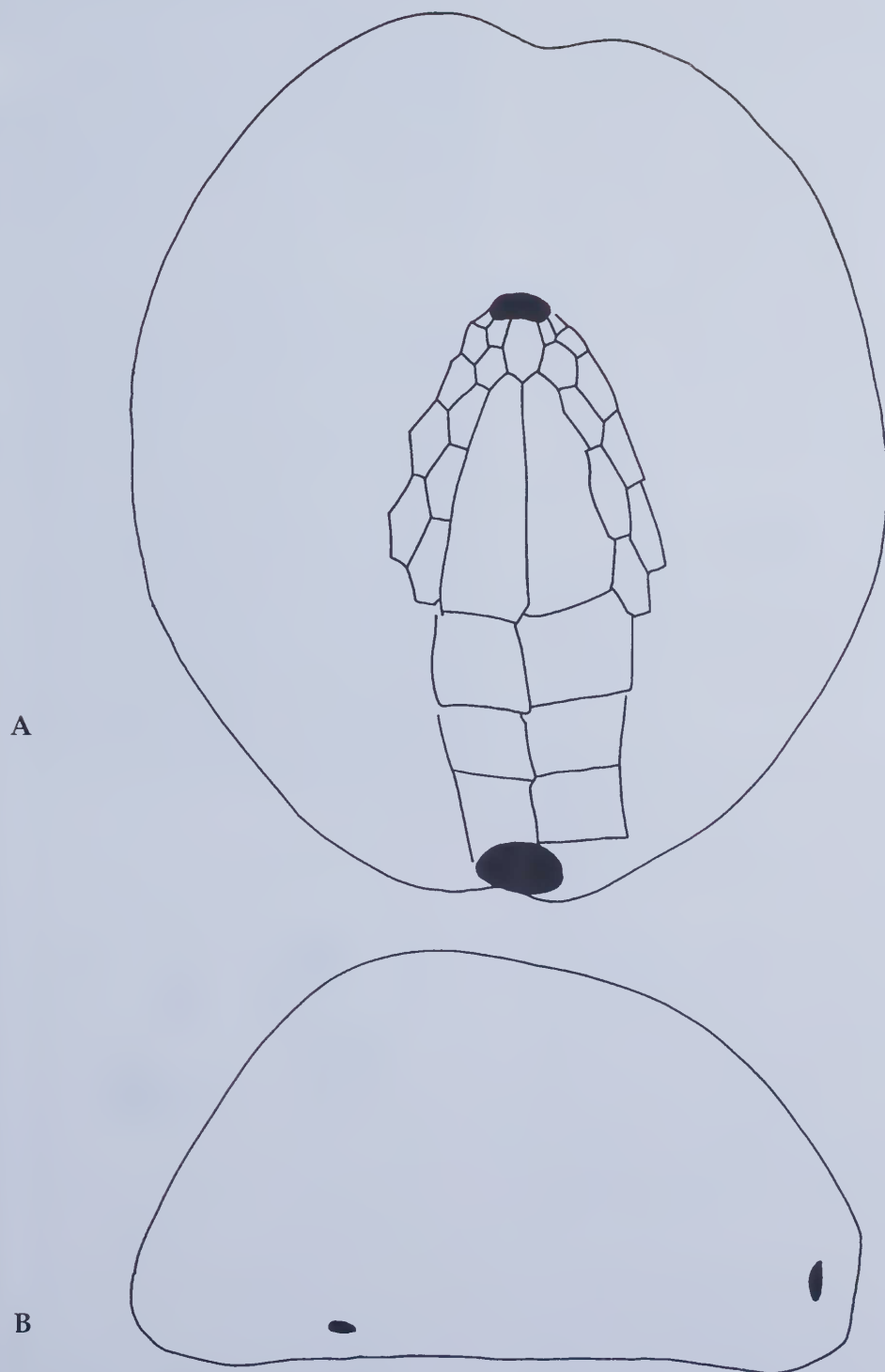
Figure 5   *Antillaster bagmanovi* sp. nov. WAM 99.432; paratype, A, partial adoral plating, B, lateral profile; from Paradash Group (Middle Eocene), Daralik, Nakhichevan region of Azerbaijan Republic; x0.9.
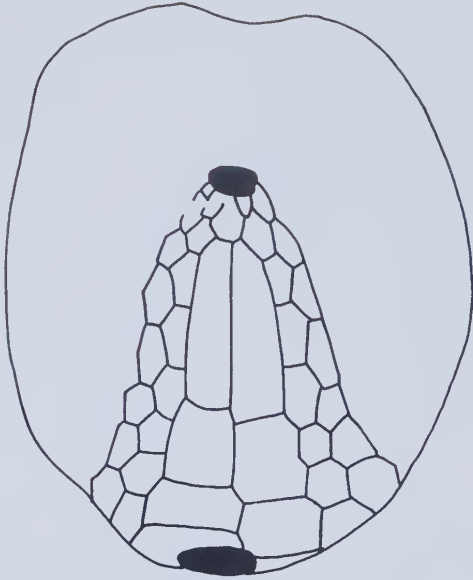
Figure 6   *Antillaster bagmanovi* sp. nov. WAM 99.429;
paratype, partial adoral plating; from
Paradash Group (Middle Eocene), Daralik,
Nakhichevan region of Azerbaijan Republic;
x1.

ambulacrum orally and narrower labrum. Another
species to possess a narrow interporiferous zone is
A. fernandezi (Sanchez Roig, 1952) from the
Oligocene-Miocene of Cuba (Kier 1984). However,
A. bagmanovi has narrower petals that are anteriorly
more divergent, a less vaulted test and four, not
three, gonopores.

Antillaster bagmanovi can also be distinguished
from *A. vaughani* (Jackson, 1922) from the
Oligocene-Miocene of Antigua, Mexico and Cuba
(Kier 1984) by its narrower interporiferous zone,
sunken petals, deeper anterior ambulacrum orally,
narrower peristome and narrower plastron. *A.
sanchezi* Lambert *in* Lambert and Thiéry, 1924 from
the Early – Middle Miocene of Cuba (Kier 1984)
has, like *A. bagmanovi*, a very narrow
interporiferous zone and slightly sunken petals, but
the Azerbaijan species has a more central apical
system, more anteriorly divergent petals that are
not so parallel-sided, and a deeper anterior
ambulacrum orally.

BIOGEOGRAPHIC IMPLICATIONS

The highly disjunct Eocene populations of
Antillaster, with nine Eocene to Miocene species in
the Caribbean and one Middle Eocene record in the
Lesser Caucasus, suggests an originally widespread
distribution as far east as the Eastern Paratheys that

contracted rapidly to the west in the Oligocene.
Whether *Antillaster* originated in the west or the
eastern parts of the orginal range is hard to
establish. Evidence from other echinoids indicates
that up until the Early Oligocene there was a
relatively free exchange of taxa across the Atlantic
Ocean, mainly in a westerly direction. For example,
Clypeaster appeared earlier in the Tethyan region
than in the Caribbean (Ali 1983). Likewise
Echinolampas first appeared in the Mediterranean
region during the Late Paleocene, but did not
appear in the Caribbean region until the Middle
Eocene (Roman 1977). Similarly *Rhyncholampas* first
appeared in the Caribbean at this time, although it
is found in the Early Eocene in France (Roman
1977). Comparable east to west migrations are
shown by *Eupatagus* (Roman 1970) and *Maretia*
(Roman 1977). Perhaps of more interest than the
likelihood of *Antillaster* forming part of this east to
west migration of faunal elements in the Middle
Eocene, is the fact that it disappeared from the
eastern part of its range so soon after. This may be a
function of its mode of life. Kier (1984) suggests
that, like living asterostomatids, *Antillaster* probably
lived on the top of the substrate, lacking features
associated with a burrowing mode of life, and in
relatively deep water, perhaps up to 800 m deep,
like living members of the family. Its disappearance
from the Lesser Caucasus may have been associated
with a shallowing of the sea as Tethys contracted
through the Cenozoic and a separation of the deep
basins of the Eastern Parathethys from deeper basins
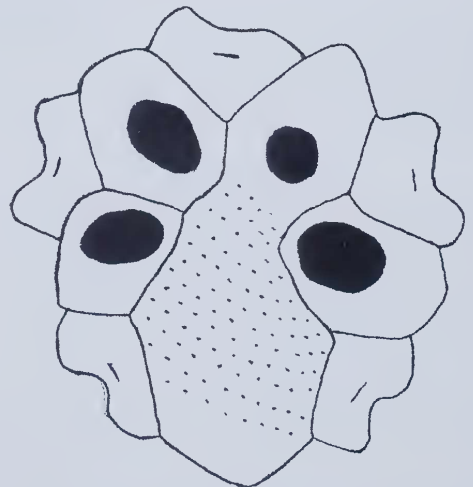to the west.

Figure 7   *Antillaster bagmanovi* sp. nov. WAM 99.431;
paratype, apical system plating; from
Paradash Group (Middle Eocene), Daralik,
Nakhichevan region of Azerbaijan Republic;
x15.

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